6 FREE FLIGHT PHASE 1, SAFE FLIGHT 21, AND CAPSTONE

The main objective of NAS modernization is to move the NAS toward a new type of flight operations known as Free Flight. Free Flight will allow pilots to change routes, speeds, or altitudes, as needed, while in en route and oceanic air space. Air traffic controllers will not impose restrictions on pilot-initiated changes, except when there is potential conflict with other aircraft or special use airspace (SUA). This capability will allow pilots to fly optimized profiles, the most efficient cruise speeds, wind-aided routes, and arrival descent profiles. Any activity that removes operational restrictions is a move toward Free Flight.

Free Flight Phase 1 Core Capabilities Limited Deployment (FFP1 CCLD) incorporates guidance provided by the NAS Modernization Task Force. FFP1 CCLD is intended to provide early user benefits and mitigate technical risk by implementing key automation capabilities at specific sites within the NAS, for evaluation by aviation stakeholders and FAA operators. The deployments will allow computer-human interface (CHI), training, and safety factors to be evaluated. After the FAA and the users have gained experience and evaluated the individual FFP1 CCLD capabilities, decisions will be made on whether to deploy them to additional locations.

Safe Flight 21 will effect integration of new technologies, systems, procedures, and training for pilots and controllers. Safe Flight 21 deploys and evaluates certain air traffic control systems and avionics that use new communications, navigation, and surveillance technologies in an operational environment. These new technologies include applications such as automated dependent surveillance broadcast (ADS-B) for air-air and air-ground surveillance, and flight information services via data link. Avionics, certification, and procedural development are cost and schedule risks that must be mitigated. Additionally, user benefits must be proven before avionics and associated ground equipment capital investments can be made.

The Alaska Capstone program will evaluate safety and efficiency improvements identified by the National Transportation Safety Board (NTSB). The project will focus on the aviation services, flight rules, and weather observations available to pilots operating in an aviation-dependent portion of western Alaska.

The following paragraphs describe the FFP1 CCLD, Safe Flight 21, and Capstone programs. These programs identify and resolve risks associated with the development and deployment of new operational tools and procedures, as well as those associated with training, human factors, and user acceptance. Additional details regarding the system and interface dependencies, on which these capabilities depend, can be found in the functional and domain sections of this document (Part III, NAS Architecture Description).

PART II

6.1 Free Flight Phase 1 Core Capabilities Limited Deployment Description

FFP1 CCLD will consist of limited deployment of controller automation decision support tools, communications, and traffic flow planning tools, which are a part of Air Traffic Management (ATM) capability. FFP1 CCLD will be deployed at selected air traffic control (ATC) facilities to obtain and evaluate early benefits to service providers and NAS users, leveraging proven technologies with procedural enhancements. FFP1 CCLD will employ an evolutionary approach to system development and deployment that maintains a high level of NAS safety. FFP1 CCLD capabilities will be deployed in phases rather than as fully mature capabilities. FFP1 CCLD is a part of NAS modernization activities and will require infrastructure support from the Host replacement, the display system replacement (DSR), and the Standard Terminal Automation Replacement System (STARS), as well as other systems and programs. FFP1 CCLD components are:

- Conflict probe (CP), as represented by the User Request Evaluation Tool core capabilities limited deployment (URET CCLD)
- Center TRACON Automation System (CTAS) Traffic Management Advisor Single Center (TMA SC)
- Passive Final Approach Spacing Tool (pFAST)
- Collaborative decisionmaking (CDM) with airline operations centers (AOCs)
- Initial Surface Movement Advisor (SMA).

Conflict Probe (URET CCLD). This capability will be added at the DSR D-side (nonradar controller) position. URET CCLD's planning capability allows the D-side controller to manage en route user requests by identifying potential air traffic conflicts. It systematically checks for conflicts between aircraft (20-minute look-ahead) and between aircraft and SUA (40-minute look-ahead). If a conflict is detected, URET CCLD will provide the D-side controller with a visual indication of the problem. Updated SUA status will be available, and URET CCLD will automatically check flight trajectories against those data to determine if an airspace conflict exists.

CTAS TMA SC. This tool will calculate meter fix crossing times for all inbound aircraft to destination runways within air route traffic control center (ARTCC) airspace. CTAS TMA SC capability will operate on the radar controller's display and in the traffic management unit. It will provide controllers with the capability to develop arrival sequence plans for selected airports and will assign aircraft to runways to optimize airport capacity. The CTAS TMA traffic management tool computes an aircraft's estimated time of arrival. It assigns a scheduled time of arrival, outer meter arcs, meter fixes, and final approach fixes for each aircraft to meet the flow constraints established by traffic management coordinators. The meter list is available to the terminal radar approach control (TRACON) facility for monitoring the final approach fix and runway threshold sequencing when the aircraft is in TRACON airspace.

CTAS pFAST. This tool adds a new capability that assists controllers to optimally merge and sequence aircraft and assign runways according to user preferences and system constraints. It maximizes runway acceptance rates and meets user needs for operational efficiency in congested terminal airspace areas. pFAST uses flight data, track information, and controller inputs to generate a set of trajectories that form the basis for computed runway assignments. The trajectories also incorporate current weather conditions and aircraft flight characteristics. The scheduled time of arrival to the assigned runway final approach fix and runway threshold is then assigned. The pFAST display will enhance controller situational awareness, especially during heavy traffic operations.

CDM. Development and deployment of this capability will focus on building automation tools that will allow the FAA and the airlines to coordinate system resources in real time in response to airspace conditions. The three tools, Enhanced Ground Delay Program, NAS Status Information, and Collaborative Routing, will provide users and service providers with timely access to information. This information sharing will be the foundation of all collaborative efforts in NAS modernization. It will provide a common view of all NAS data and promote a cooperative effort to manage NAS traffic. Traffic flow managers' decisionmaking will improve because of the availability of better NAS user intent data, while NAS user decisionmaking will improve because of more timely and complete information on NAS operational status.

Initial SMA. This tool provides a one-way feed of arriving traffic information from the approach control automation system to ramp control computers for airline personnel use. Ramp controllers will use this information to plan and manage aircraft movement to/from gates and on ramp areas. This will improve gate operations and ground support services, resulting in a reduction of taxi times and takeoff delays.

The goal of FFP1 CCLD is to evaluate these automated decision support capabilities by the end of 2002 and begin national deployment during NAS Modernization Phase 2. FFP1 CCLD will not be a full-scale test of NAS modernization, but rather a limited test of decision support automation systems. The FFP1 CCLD program will be designed to derive early benefits from automation system upgrades as part of the larger NAS modernization program.

6.2 Safe Flight 21

The Safe Flight 21 project has replaced the Flight 2000 program. This government/industry initiative is designed to demonstrate and validate, in a real-world operational environment, the capabilities of advanced communication, navigation, and surveillance technologies, associated air traffic systems, and the pilot/controller procedures. Following are Safe Flight 21 capabilities and procedures, which constitute the means to move toward Free Flight.

- *Flight Information Services (FIS) for Presenting SUA Status, Weather, Windshear, Notices to Airmen (NOTAMs), and Pilot Reports (PIREPs) to Pilots.* Enhanced graphical and tabular information will be electronically transmitted to the cockpit. Data will be used to improve the content and timeliness of relevant flight planning information.
- *Controlled Flight Into Terrain (CFIT) Avoidance Through Graphical Position Display.* This will provide cost-effective terrain data in the cockpit to all airspace users for improved situational awareness.
- *Improved Terminal Operations in Low-Visibility Conditions.* This will provide improved situational awareness in the cockpit by using ADS-B position information of nearby aircraft. Data will be presented on a cockpit display of traffic information (CDTI) to enable the pilot to judge distance and speed of preceding aircraft in marginal weather conditions. This will yield benefits from increased arrival rates and access to airports.
- *Enhanced See and Avoid.* Integration of several communications, navigation, and surveillance (CNS) capabilities will be demonstrated to electronically provide improved traffic information to the pilot. Three ADS-B links with CDTI (1090 MHz, UAT, and very high frequency digital link (VDL) Mode-4) will be evaluated to determine which works best and is most compatible with the NAS infrastructure.
- *Enhance Operations for En Route Air-Air.* Use of ADS-B, CDTI, data link, and related technologies will be evaluated to examine the potential for delegating separation authority to the cockpit.
- *Improved Surface Navigation.* The capability of ADS-B, CDTI, and data link to improve the ability of the pilot to navigate on the airport surface in all weather conditions will be evaluated.
- *Enhanced Airport Surveillance for the Controller.* The enhanced information provided the pilot would also be provided to the controller through a digital data link. This information can be integrated with the radar data at airports equipped with ASDE surface radar.
- *ADS-B Surveillance in Nonradar Airspace.* Use of ADS-B will be examined in areas outside of radar coverage to allow controllers to provide separation services rather than procedural separation. Benefits expected would be increased safety, access to airspace, and route flexibility.
- *Establish ADS-B Separation Standards.* Integration and fusion of surveillance data from ADS-B and normal radar data will be tested for the possibility of reducing separation standards.

The Safe Flight 21 activity venues will include the Ohio Valley—with the Cargo Airline Association (CAA)—and in Alaska. The Safe Flight 21 project will focus primarily on developing a suitable avionics technology, pilot procedures for air-air surveillance, and developing a compatible ground-based automatic dependent surveillance system for ATC. The Ohio Valley venue of Safe Flight 21 will test three candidate avionics/data link technologies for air-air surveillance. They are the universal access transceiver (UAT), the self-organizing time division multiple access (STDMA) radio (also known as VHF data link-Mode-4, or VDL-4), and the Mode-S (1090 MHz) squitter.

The Ohio Valley venue will help test avionics, which periodically broadcasts the aircraft position (i.e., ADS-B), derived from the Global Positioning System/Wide Area Augmentation System (GPS/WAAS). These tests will occur in the terminal areas, which support cargo aircraft operations at Memphis, Wilmington, Louisville, Scott AFB, and Nashville. ADS-B-equipped aircraft will be able to receive the broadcast and display the position of other ADS-B-equipped aircraft CDTI. Pilots will use the CDTI display to:

- Identify and follow aircraft in the arrival pattern, thus maintaining higher arrival rates during reduced visibility conditions in the terminal area
- Provide situational awareness of the position of nearby aircraft.

The Ohio Valley project will also use GPS Local Area Augmentation (LAAS) avionics and the CDTI display with a moving map feature to help pilots taxi on the airport surface during reduced visibility conditions. GPS LAAS avionics will provide the precise navigation position required for arrival and surface operations. Vehicles that operate on the airport movement area will also be equipped with comparable equipment.

Finally, the Alaska portion of the Safe Flight 21 project will integrate ADS data and radar data to determine if aircraft separation standards can be reduced. Except for testing use of air-air surveillance to maintain higher arrival rates during reduced visibility conditions in the terminal area, the Safe Flight 21 program will test all of the above concepts in Alaska.

As we evolve toward Free Flight, Safe Flight 21 will help accelerate implementation of NAS technologies and approval of procedures needed to achieve full operational efficiency and safety benefits. This early demonstration and validation of operational enhancements will also serve to reduce the near-term risk of implementing new technologies and the long-term risk and cost of transitioning to the remainder of the NAS. Certification activities associated with Safe Flight 21 will ensure that Free Flight technologies and procedures will meet FAA safety requirements while providing benefit.

6.3 Capstone

The FAA Alaskan Region's Capstone Program of infrastructure modernization provides and validates safety and efficiency improvements recommended in the NTSB Safety Study (NTSB/SS95/05), *Aviation Safety in Alaska.* Capstone focuses on safety by improving infrastructure in Bethel and the surrounding area, a small portion of western Alaska. It will address the operating environment and aviation infrastructure, weather observations and recording, airport condition reporting and adequacy of the current instrument flight rules system. A coalition of Congress, FAA, and the Alaskan Aviation Industry Council supports Capstone as an essential safety enhancement to this aviation-dependent environment. Additionally, these Alaskan modernization efforts will precede and can complement the data collection and risk-reduction efforts of the Safe Flight 21 program. This will occur in three areas: avoidance of controlled flight into terrain, procedural development for enhanced see-and-avoid, and flight information services product development.

6.4 Risk Mitigation

The FAA's Acquisition Management System requires risk management to be conducted throughout all phases of the system life cycle. It is important to monitor risks because mission needs, system requirements, technology opportunities, and program status change frequently. It is especially important to continually monitor risks during NAS modernization because of the interdependencies among programs.

The NAS is an integrated collection of systems that deliver a set of capabilities to NAS users and NAS service providers. A change in one system can adversely affect others. Risk management reduces the number of situations that become problems as well as their consequences. The NAS Architecture is where interdependent program risks can best be identified, analyzed, tracked, and mitigated. Risk management will result in a greater percentage of projects being delivered on time, within cost, and that meet performance expectations.

Risk management is an integral part of program management, which helps implement a system successfully. It can be defined as a five-step process, that focuses on identifying risks, analyzing risks, prioritizing risks, mitigating risks, and tracking and controlling risks. These five steps are discussed in more detail below. The goal of risk management is to invest a small amount of money and time, relative to the total value of the program, to reduce the probability or impact of unplanned events by taking action before a situation becomes a NAS-wide issue. Risk management is preferred because the cost is lower to resolve a problem early, and the time available for developing and considering options is greater, which increases flexibility in dealing with situations.

6.4.1 Risk Management Process

The five steps of risk management are:

- **Identification.** Risks must be identified before they can be managed. One way to ensure more complete risk identification is to categorize the risks. The categories used for NAS modernization are:
  - *Technical.* Technical risks are present in a program whenever a new technology is being introduced. It is often uncertain if a system can be built with the required performance.
  - *Operational.* Operational risk is the likelihood that the system that is built will improve the performance of NAS users or service providers.
  - *Support.* Support risks relate to the ability of the system to be adequately maintained or operated as intended, including the adequacy of training.
  - *Cost/Benefit.* Cost risk reflects the likelihood that a program will exceed the acquisition program baseline (APB). Cost-benefit risk is the probability that the initiative or activity will not deliver the benefit for which it was developed.
  - *Deployment.* Deployment risk is the likelihood that, even though a system has been developed successfully, there will be delays in achieving full operating capability because procedures and policies for using the new capabilities are not in place.
- **Analysis.** Risk analysis quantifies the probability of the risk event occurring and the impact (consequences) on the program. The analysis phase includes evaluating program dependencies that contribute to risks by increasing the impact or certainty of a risk event. To understand the total effect of a risk and later define a priority, the risk exposure must be considered. Risk exposure is the combination of the risk probability and the risk impact. As a general rule, the architecture assumes the higher the risk exposure, the higher the priority.
- **Prioritization.** Prioritization helps to apply limited resources to effectively mitigate risk. Risk analysis estimates the risk exposure for various activities. Usually, the highest exposure risks are dealt with first. In addition to the probability and consequences of a risk event, the following factors are taken into account: time criticality of mitigation; time of consequences; the cost of mitigation activities; or the perception of the importance of the risk to the user community.
- **Mitigation.** Risk-mitigation activities on a single program are usually separate, parallel activities that attempt to reduce the likelihood that a risk event will occur, or reduce the consequences of a risk event if it occurs. Risk-mitigation activities include analyses, modeling, prototyping, human-in-the-loop experimentation, parallel alternative development, limited field testing, and other activities designed to increase the success of implementing a capability. Risk mitigation for interdependent activities can be more complex. It is critical for NAS modernization that the combined risks of multiple deployments be assessed as early as possible so that mitigation plans can be implemented.
- **Tracking and Control.** As programs that provide new or improved capabilities for the NAS proceed, their risks change constantly. Every program that is practicing risk management will perform risk tracking and control. Periodically, risks will be evaluated and reprioritized and the risk management strategies adapted accordingly.

6.4.2 Risk Mitigation in Free Flight Phase 1 CCLD

NAS evolution will use a spiral development process. FFP1 CCLD, the first spiral development step, is designed to mitigate risk and evaluate early user benefits at a limited number of sites. FFP1 CCLD capability deployment will occur simultaneously with, and depend on, other modernization activities in NAS Modernization Phase 1. FFP1 CCLD will identify and resolve some of the significant risks associated with the development/deployment of new decision support tools, including procedure development, training, human factors, and user acceptance.

Technical

The future NAS will be composed of multiple new integrated systems. For example, in the en route domain, Traffic Management Advisor

(TMA), CP, data link applications processor (DLAP), weather and radar processor (WARP), and Host/oceanic computer system replacement (HOCSR) will be connected to the NAS local area network (LAN). Consequently, there is a risk that one system could adversely affect the operation of other systems connected to the NAS LAN. FFP1 CCLD will help mitigate these risks through system engineering analysis, deployment, and evaluation at multiple select sites. Information security presents risks. Since many of the new systems employ open architectures and modem networking techniques to distribute and collect information, these systems are vulnerable. These vulnerabilities must be resolved in the early development stage so that risk and cost are minimized.

Operational

The concept of operations cannot be met without new procedures and policies. Information provided by new capabilities will introduce coordination risks that will require changes in NAS participants' roles and responsibilities. Substituting data link messages for voice messages from controller to pilots will require new pilot-to-controller acknowledgment procedures. The objective of CPDLC Build 1 is to test initial procedures and then refine and validate these procedures prior to national deployment.

New capabilities must be operationally acceptable in order for service providers and aircraft operators to use them. Even though the capabilities will have been demonstrated and simulated, there is still a risk that they may not be operationally acceptable. FFP1 CCLD will mitigate this risk through limited deployment and working out the human factor issues. This will help determine performance tradeoffs for operational acceptability and identify unknown human factor issues. Although the new capabilities that make up FFP1 CCLD are designed to produce benefits independent of deployment site, sites differ in many respects. There is a risk that specific capabilities may not be operationally suitable at other sites. FFP1 CCLD addresses this risk by deploying some capabilities to sites with different characteristics. Evaluating the operational suitability at various sites will help define the criteria for national deployment.

Cost/Benefits

Early user benefits will help determine whether to deploy the new capabilities beyond the limited number of FFP1 CCLD sites. The benefits must exceed the costs of implementing, deploying, operating, and maintaining the systems that deliver the capabilities.

Deployment

The deployment schedule will address the ability of users and service providers to accept and implement new systems in a timely manner. Concerns include training schedules, system integration into existing infrastructure, and availability of technical staff to perform the installation.

6.4.3 Risk Mitigation in Safe Flight 21

Safe Flight 21 will provide early field experience to determine the operational acceptability and benefits of proposed new CNS technologies and capabilities, thus mitigating national deployment risks. The following describes some of the risks to be mitigated.

Technical

Safe Flight 21 risk-mitigation areas include certification of avionics and ground systems, requirement stabilization, information security, systems integration, and standards.

Operational

Risk will be reduced through development and validation of new controller and pilot procedures. Validation of initial user benefits will be accomplished in an operational environment.

Cost/Benefits

Products used to provide improved capabilities will be assessed for reliability and ease of use. Safe Flight 21 will enable user avionics equipage costs to be accurately determined.

Deployment

Safe Flight 21 will mitigate deployment schedule risks by involving the user community in the development and use of new avionics and related operational capabilities. User recognition of the benefits derived from these new capabilities will encourage avionics equipage and ensure ground systems deployment in a timely manner. The schedule will be harmonized with the rate of avionics equipage. Experience gained through Safe Flight 21 is expected to expedite the certification of new avionics and ground systems.

6.4.4 Risk Mitigation in Capstone

Technical

Capstone risk-mitigation areas include initial certification of avionics and ground systems, requirement stabilization, systems integration, and standards.

Operational

Risk will be reduced through development and validation of new controller and pilot procedures. Validation of initial user benefits will be accomplished in an operational environment.

Cost/Benefits and Deployment

Capstone will provide the initial data collection for making risk-reducing decisions.

6.5 Summary

The Architecture Version 4.0 provides a disciplined, structured, phased approach to changing the NAS. The architecture uses appropriate program management techniques that rely on risk management. As described earlier, FFP1 CCLD, Safe Flight 21, and Capstone will serve to mitigate risks in modernizing the NAS. Using the five-step approach and adopting a spiral evolutionary strategy that includes FFP1 CCLD, Safe Flight 21, and Capstone, the NAS architecture applies sound risk-management principles to meeting the modernization objectives.